



**US Army Corps
Of Engineers**

Hydrologic Engineering Center

Fourth Quarter Activity Report

FY 2000

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Executive Summary

Top priorities for FY 2000 were our Corps Water Management System modernization software development and integration project, NexGen software research and development project, watershed and water resource system analysis, and comprehensive system studies. Progress was substantial in all these areas. Customer demand for HEC services and products continues to be high. Our reimbursable projects program continues strong, resulting in another fiscal high at year-end. Many of the senior professional staff are reaching retirement age and retirements have commenced. The pace will quicken in FY 2001 on through 2002. Restocking of staff has commenced in earnest.

The project to modernize the Water Control Data System (WCDS) software began in FY97. Because the modernized system will be much more than a data system, it was renamed to the Corps Water Management System (CWMS). CWMS is the decision support Automated Information Systems (AIS) that supports the Corps water management mission. It embodies data acquisition, validation, transformation and management; forecasting, simulation and decision support analysis; and information dissemination. Modernizing and deploying the corporate software for CWMS is a six-year, \$7.6 million centrally PRIP funded, Corps AIS improvement project managed under the Corps Life Cycle Management of Information Systems (LCMIS) process. The management structure and design teams form a unique arrangement for providing oversight and field participation in the enterprise-wide development and integration project. The significant accomplishment in FY 2000 was installation of Test Version 2.0 at four field sites. This is the second planned interim test installation prior to Test 3.0/CWMS Version 1.0, which will complete the system. CWMS is scheduled to be deployed Corps-wide in 2001/2002. The project is on schedule and within budget. Project documents are available on the project Internet Web site: (<http://cw71.cw-wc.usace.army.mil/cwcinfo/cwc.html>).

The NexGen software research and development project continues to roll out products for Corps field offices. There are now Arc/Info and ArcView version of HEC-GeoRAS, providing GIS utility support for HEC-RAS, the widely popular river hydraulics software package. HEC-HMS (Version 2.0) was also released. This new version of the Corps standard watershed model includes a moisture accounting loss algorithm. Work is now underway on the next version that will add dam safety and planning analysis capabilities. A pre-release of the unsteady flow version of HEC-RAS (Version 3.0) was released for testing. Public release is expected early next fiscal year. A GIS utility package (HEC-GeoHMS) was released in the summer. This utility provides substantial capability to effectively use national terrain data sets to rapidly develop HEC-HMS models. Building models for the tributaries to the Central Valley of California was the shakedown application of GeoHMS. The major flood damage and risk analysis software package, HEC-FDA, continues to be improved. The two new NexGen software programs that are components of CWMS were improved and are included in CWMS Test Version 2.0. They are a new simulation/real-time reservoir operations model, and a flood impact analysis model. These programs will continue to be improved and will likely be released within the Corps, in stand-alone form late in FY 2001.

One aspect of our activities in the risk-based analysis and flood frequency analysis areas was completed this past year. The panel of The National Academy of Sciences, National Research Council (NRC) that reviewed the Corps use of risk-based analysis delivered its final report this year. HEC represented the Corps, attending meetings, making presentations, and exchanging information on this topic. The report focused substantially on the HEC-FDA program that provides the analytical tool for implementing risk analysis in the field. In general, the NRC

report commends the Corps for their risk analysis initiative, and encourages continued development of the methodology. Suggestions for improvements are made in several areas. We began a research project to address hydrologic risk and uncertainty and environment restoration performance. This is an area of inquiry that is expected to grow. The restudy of flood frequency on the upper Mississippi River, in light of the flood of 1993, continues to close in on the final phase. A report documenting the flow frequency analysis methods and preliminary results was completed. A case example application of extreme flood magnitude and frequency estimates was initiated as part of the new Dam Safety R&D. Preliminary results are expected in FY 2001.

Six PROSPECT courses were conducted for a total of six weeks of training. The courses covered several hydrologic engineering and planning analysis topics including HEC-RAS, HEC-HMS, GIS applications, and two new watershed/river and wetlands restoration courses. Attendance averaged about 25 students per course. Five on-site workshops were also held totaling four weeks of sessions for 150 students. While this continued the recent trend of reduced PROSPECT sign-ups and increased requests for on-site workshops, FY 2001 looks to reverse the trend with up to ten PROSPECT courses likely to be presented. Topics presented in the workshops included HEC-RAS, HEC-HMS, and hydrologic engineering in planning.

Reimbursable project work was undertaken for 14 Corps field offices as well as HQUSACE, the Federal Emergency Management Agency, University of California, and the National Institute for Building Sciences. Projects include watershed and reservoir system modeling, water quality, risk analysis, river hydraulics, wetlands hydrology, water control management, regional statistical analysis, flood damage analysis, GIS applications in hydrology and hydraulics, and groundwater modeling. In the upper Mississippi, HEC is managing the project to update the model geometry for the Mississippi Basin Model System (MBMS) to reflect more recent mapping and to develop an inundation mapping component based on the new mapping was re-activated this year. Map products from the contractors continue to lag resulting in a one-for-one lag in the project, with late delivery of up to eighteen months likely. Remaining work includes cutting the new river section geometry, integrating these new digital map-based geometry sections into the UNET models, re-calibrate the models, and prepare final reports. It is clear that the Corps will not receive contractor map products in time to complete the project in fiscal year 2000. Work will need to continue through FY 2001 before completion can be declared. The reimbursable project to assist in modeling the Sacramento and San Joaquin river basins for flood control operations is moving toward the documentation phase. This is part of a comprehensive study by Sacramento District to review the flood damage reduction system for the Central Valley of California. Preliminary models were completed in Phase I, and improved models are now near completion under Phase II. The models (separate models for the Sacramento Valley and San Joaquin Valley) are: HEC-5 for flood control operations; HEC-FCLP, system flood control operation optimization; HEC-FIA, flood economic/damage impact analysis model, and HEC-HMS (flood runoff model). Data compilation, and some of model development will later serve as the base for modernized CWMS implementation for these areas. We began an interesting project that is developing a flood forecast system for an area of the Susquehanna basin that has as its final outputs, forecast flood inundation map with associated flood damage— a first. Work will continue through this year into spring FY 2001. The total reimbursable project program was over \$2.0 million with individual projects ranging from a few thousand dollars to near a million.

The HEC program for FY 2001 will continue FY 2000 efforts at the brisk pace reflected at the end of the year. We will continue fielding new versions of the NexGen software packages HEC-RAS, HEC-HMS, and HEC-FDA, and companion GIS utility software. Also emerging will be the first public release of the new reservoir simulation program HEC-ResSim, and initial unsteady flow capability of HEC-RAS (Version 3.0). Test Version 3.0 of the modernized CWMS will be installed and tested in five Corps offices, LCMIS Milestone Decision III secured, and Corps-wide deployment commence. PROSPECT training will increase to about ten courses and the number

of field workshops will likely continue at about the same rate. Research and Development funding is expected to continue to decline - not a good trend, software maintenance and support and WCDS modernization funding will remain at about FY 2000 levels, and reimbursable technical assistance and special projects will likely level off. On balance, the result is expected to be a stable to slight increase in funding over that of FY 2000. The reorganization of HQUSACE, is complete, with HEC reassigned as a Center within the Institute for Water Resources. We expect increased synergy with other IWR elements, and anticipate no adverse affect on services to our customers.

Darryl W. Davis, P.E.
Director

Research and Development

Hydrologic Engineering Research Program

Catchment Analysis System

Work Unit 32444 (hydrology & hydraulics technology 4th/00 R00-001)

The development of HEC-HMS Version 2.1 is complete. Computational-engine enhancements for new hypothetical storms, SCS storms, and paired-data usage and the graphic user interface components for controlling the new features were completed. Next quarter Version 2.1 will be thoroughly tested, the user's manual updated, and program release documents developed. The release is expected in January 2001.

Design efforts continue for three new computational-engine capabilities: improved reservoir modeling, snowmelt, and frequency curve generation. The current reservoir element is only capable of simulating very simple reservoirs that must be described by a user-specified storage-outflow curve. The design effort will expand usability by allowing the user to specify spillway and outlet structures; dam break simulation will also be included. Snowmelt and frequency curve generation are not currently included in the program. Initial snowmelt capabilities will include a degree-day method with energy and gridded techniques to follow at a later date. Frequency curve generation will be developed for both event and continuous contexts. The reservoir element improvements are currently targeted for Version 2.2 late next FY, while the other capabilities have not yet been scheduled.

A new design for the HEC-HMS graphic user interface was completed and presented to HEC staff. The new interface will be developed in Java and will replace the existing Galaxy interface. Lessons learned with Galaxy technology, user feedback, and other resources are being applied to design a state-of-the-art replacement interface using Java technology. Particular attention is being given to visibility, affordability, and workflow. It is anticipated that the new interface will debut with Version 3.0 after the Version 2.2 release with the current Galaxy technology.

Resolving Water Allocation and Use Conflicts

Work Unit 32976 (water resource systems 4th/00 R00-003)

HEC develops and applies reservoir system optimization programs to assist in resolving water allocation and use conflicts that arise from changing conditions. The Prescriptive Reservoir Model (HEC-ResPrm) and HEC- Flood Control Optimization program (HEC-ResFloodOpt) are the two primary programs developed and applied under this work unit. PRM uses a monthly time step and is therefore most applicable for conservation studies. ResFloodOpt is a flood analysis tool. They will be incorporated into the Reservoir Evaluation System (RES) program, along with the simulation component, ResSim, which continues under development by other funding sources. During the past two years this work unit has concentrated on the ResFloodOpt, the flood control linear and mixed integer optimization program. We continue making strides towards making it a viable tool for both the derivation of system operation rules and in optimal operation of forecasted events. We continue to push the operations research's state-of-the-art for flood analysis by enabling more detailed representation of the reservoir system. Procedures to limit the foresight and means to better mimic overall system reservoir outflow and weir flow conditions are examples of on-going enhancements under are under development. In 1999, HEC-ResFloodOpt was applied to the Iowa and Des Moines rivers system. It is presently being used in the Phase II Sacramento District Comprehensive Study. A draft of the user's manual and a technical reference guide were completed during the fourth quarter.

Unsteady Modeling for River Analysis

Work Unit 33275 (hydrology & hydraulics technology 4th/00 R00-004)

This work unit was initiated this FY to develop an unsteady-flow modeling capability and incorporate it into the HEC-RAS computer program. The goal is to develop and provide a complete set of unsteady-flow options to complement the steady-flow options developed under the river analysis work unit. During the third quarter of FY 2000 a beta version of HEC-RAS (version 3.0 beta) was released. During the fourth quarter many more persons from the Corps and the profession volunteered to become beta testers. New interim releases of the beta version were released as capabilities were added and bugs were fixed. Feedback from beta testers has been most helpful. Version 3.0 will be finalized and documented in the first quarter of FY 2001. The addition of unsteady flow to HEC-RAS is a major advance in the Corps river hydraulics analysis capability.

Reservoir Analysis System

Work Unit 32602 (water resource systems 4th/00 R00-005)

This work unit develops reservoir tools to facilitate analyses ranging from planning studies to detailed system regulation for flood and conservation operations. The Reservoir Evaluation System (HEC-Res) family of programs include: the simulation component (ResSim), the flood optimization component (ResFloodOpt), and the Prescription Reservoir Model (ResPrm). The Res program will enable users to define a common set of system configuration and physical system parameters in common all analysis components. Only the pertinent data associated with the individual analyses components are entered to run the program. In FY 1995, a requirements document for a new reservoir model was written and, in 1997 a reservoir GUI was developed to create model data and run computer programs HEC-5 and HEC-Prm. In FY 1998, the focus shifted to develop a prototype reservoir model for the Corps Water Management System (CWMS). A software design was thus prepared. A functional ResSim program, with limited detailed outlet and system capabilities, was completed in the third quarter on this FY and taught extensively in HEC's Reservoir System Prospect course. A fully functional version is schedule for completion during the third quarter of FY 2001 for deployment with CWMS Version 1.0. Version 1.0 of HEC-Res is targeted for release by the end of the calendar year.

Integration of NexGen for Watershed Studies

Work Unit 33268 (water resource systems 4th/00 R00-006)

Creation of procedures and capabilities to provide an integrated interface of HEC models for water resources planning and watershed management analysis studies are the objectives of this new work unit. A watershed/planning style Control and Visualization Interface (CAVI), tailored after the Corps Water Management System (CWMS) CAVI, will link the suite of models, data processing, and spatially referenced displays. The CAVI design was initiated during the third quarter and continued to evolve during this quarter. A functional prototype is targeted for FY 2001. The final product will streamline the analysis process while producing more consistent results and shared displays.

Terrain-Based H&H Modeling

Work Unit 32975 (hydrology & hydraulics technology 4th/00 R00-007)

HEC-GeoHMS Version 1.0 software and documentation were released. It was initially introduced at the 20th Annual ESRI Users Conference and a paper is included in the proceedings. The USGS is using the software in their project to develop a hydrologically corrected terrain data set for the USA. This first release of GeoHMS is the result of extensive development and testing of the software by HEC and its Cooperative Research and Development Agreement, CRADA, partner, ESRI.

HEC-GeoRAS Version 3.0 and documentation were released. Distribution of the software will occur with the distribution of HEC-RAS Version 3.0. HEC will be applying the GeoRAS software to assist in the hydraulic study of approximately 110 river miles on the Susquehanna River during FY 2001. Procedures for enhanced functionality have been designed for GeoRAS Version 3.1. It is expected that these features will be implemented during the first quarter of FY01.

Urban Hydrology and Hydraulics Methods/Models

Work Unit 32875 (hydrology & hydraulics technology 4th/00 R00-008A)

The previously developed example application to illustrate a method for improved hydrologic routing through a hydraulic structure with backwater conditions was documented. Additional procedures to connect hydraulics information from HEC-RAS to HEC-HMS will be included in work units next FY. The use of the RAS hydraulics library more directly by HMS will be a prime consideration. A state-of-the-art review of methods for simulating non-point source water quality in hydrologic models was made. It will be documented next FY as guidance for implementing environmental analysis capabilities in HMS.

Flood Damage Analysis

Work Unit 32876 (water resource systems 4th/00 R00-009)

HEC continues to develop software for more efficient flood damage and plan formulation and evaluation computations. The work unit efforts are coordinated with the Risk Analysis Work Unit 32896 and Geographic Information System Work Unit 33173, Flood Damage Analysis (FDA) Using GIS Technology. Work during FY 2000 concentrated on development of the new HEC-FDA Version 2.0 package, a significant advance over the earlier versions of HEC-FDA. The highly integrated package features the familiar HEC-FDA risk-based analysis capabilities for flood damage reduction studies, plus the Flood Impact Analysis (FIA) program event/continuous record analysis, and user interactive analysis and displays using spatially referenced data. The conversion of HEC-FDA to a Java user interface with the spatially referenced displays similar to other NexGen programs continued.

Flood Hydrology and Hydraulics of Wetlands

Work Unit 33291 (hydrology & hydraulics technology 4th/00 R00-010)

The limited funding this FY provided for some literature review and participation in Corps meetings to define environmental modeling needs. The materials developed were presented in a Corps PROSPECT course. The main body of the work will begin next FY if funded.

Improved Streamflow Estimation and Project-Aquifer Impact Analysis

Work Unit 32703 (hydrology & hydraulics technology 4th/00 R00-022)

The work unit was suspended this FY because of limited funding.

Risk Assessment Research Program

Hydrologic Risk & Uncertainty & Environmental Restoration Performance

Work Unit 33214 (water resource systems 4th/00 R00-031)

This work unit targets development of procedures and documents for hydrologic engineering analysis associated with riverine environmental restoration studies. The analysis of low- and high-flow regimes affecting the design, maintenance, and operation of the project over its life is quantified along with associated uncertainty considerations of the project. Emphasis is on

defining and developing methods for hydrologic variables, and defining key uncertainty components that are important to riverine restoration investigations. The HEC work is part of associated efforts of the Environmental Lab (CEERD-EV) and the Institute for Water Resources (CEWRC-IWR) who are responsible for the biological and policy aspects of the R & D work, respectively. HEC's fourth quarter activities continued with the development of a draft of a Hydrologic/Hydraulics Guide Manual for Riverine Restoration Studies. HEC conducted extensive phone interviews with most Corps offices to discuss their experiences in developing the hydrology and hydraulics portions of constructed riverine wetland studies. A case study example will be included in the guide manual.

Residual Risk of FDR Projects

Work Unit 33289 (water resource systems 4th/00 R00-032)

The objective of the new Residual Risk research is to create procedures and capabilities to define and communicate the residual flood risk for various project types (levees, channels, detention storage, nonstructural measures) and study settings (population at risk, egress, damage potential). This will include information on the flood characteristics resulting from impaired-operation for a range of events; development of project performance risk indicators and information; and assessment of capacity exceedance event impacts on the physical setting, general population, and responsible response agencies. The procedures are to be performed within existing Corps engineering requirements and include such components as risk-based analysis approaches. Spatially referenced data sets representing flood inundation, velocity, and warning time layers on aerial photographs were used as tests to assist in depicting the residual risk associated with forecasted, observed, or hypothetical events during the fourth quarter.

Geographic Information System Research Program

Flood Damage Analysis Using GIS Technology

Work Unit 33173 (water resource systems 4th/00 R00-040)

The use of spatially referenced data for flood damage analysis and displays are the basis of this R&D effort. It focuses on development of software to conduct flood damage analyses in a more integrated manner, reduce field survey time and effort, and generate easier to interpret output and displays. The approaches will be integrated into the HEC-FDA Version 2.0 package. The design and implementation is also closely coordinated with flood impact analysis software being developed under CWMS activities. The design of the structure inventory component using grid-cell analysis for land use categories and census block data was completed during the fourth quarter.

Risk Analysis for Dam Safety Research Program

Assessing Hydrologic Loading Uncertainty

Work Unit 33257 (hydrology & hydraulics technology 4th/00 R99-051)

A stochastic watershed model is being developed, by modifying HEC-1 watershed model computation routines to perform stochastic modeling. The modifications are progressing so that an application to the American River Case Study can be performed next FY.

Estimating Probability of Extreme Floods

Work Unit 33258 (hydrology & hydraulics technology 4th/00 R99-052)

Work was initiated on developing a stochastic precipitation model for the American River Watershed Case Study. Current work is concentrating on estimating storm depth area reduction factors for the area. These factors will be combined with the previous work on precipitation depth-duration-frequency relationships to stochastically generate storms.

Corps Water Management System

The project to modernize the Water Control Data System (WCDS) software began in FY97. Because the modernized system will be much more than a data system, it was renamed to the Corps Water Management System (CWMS). CWMS is the decision support Automated Information Systems (AIS) that supports the Corps water management mission. It embodies data acquisition, validation, transformation and management; forecasting, simulation and decision support analysis; and information dissemination. Modernizing and deploying the corporate software for CWMS is a six-year, \$7.6 million centrally PRIP funded, Corps AIS improvement project managed under the Corps Life Cycle Management of Information Systems (LCMIS) process. The management structure and design teams form a unique arrangement for providing oversight and field participation in the enterprise-wide development and integration project. The significant accomplishment in FY 2000 was installation of Test Version 2.0 at four field sites. This is the second planned interim test installation prior to Test 3.0/CWMS Version 1.0, which will complete the system. CWMS is scheduled to be deployed Corps-wide in 2001/2002. The project is on schedule and within budget. Project documents are available on the project Internet Web site: (<http://cw71.cw-wc.usace.army.mil/cwcinfo/cwc.html>).

Data Capture

(water management systems 4th/00 W00-050)

The data capture software manages data streams of GOES and/or AFOS (SHEF) data. The streams are obtained from a StreamSender server process, which may reside anywhere in the network and is fed into the Corps Water Management System (CWMS), where it is decoded and posted to the Oracle database. The data capture process is being tested on a continuous basis, 24 hours a day and 7 days a week, at four field sites. Active messaging (Alarms) for data capture components were developed and are being tested at the four field sites for the expected data arriving in Oracle.

Data Decoding, Transformation and Validation

(water management systems 4th/00 W00-051)

Work continued on the development and implementation of the comprehensive validation and transformation of data as it comes into the data acquisition module in real time. The validate/transform component being developed fits into the existing WCDS system architecture. These components are integrated with ProcessShefit, and use ProcessShefit data statistics to guide the comprehensive validate/transform process. ProcessShefit stores each time series description, latest value, and latest time of observation. ProcessShefit writes this data to the validate-transform control files at defined intervals with the specific time that the interval occurred, determining the file name. ProcessShefit records the minimum and maximum times that are later used to form a time window for the validate/transform process that is executed after a user-defined interval of time has elapsed. The validate/transform server monitors a watched directory and launches when a file comes in, the dependencies criteria is used to develop an extract of the data needed for the validation and transformation process to be executed. Limited testing was done during this quarter.

Flow Forecasting and Forecast Evaluation

(water management systems 4th/00 W00-055)

Testing of the flow forecasting components of CWMS Test Version 2.0 at field sites revealed some flaws in the water control features of HEC-HMS. Specifically, HMS failed to properly convert units for blending of observed flows with calculated flows. The sources of these problems have been identified and remedies are being programmed.

Design of features for HFP and MFP for Test Version 3.0 is under way. MFP will be able to import QPF (quantitative precipitation forecast) data for the look-ahead portion of its simulations. HFP will have significantly enhanced reporting capabilities for hydrologic modeling results, and will incorporate parameter optimization functions from HMS, so that hydrologic modeling parameters can be adjusted automatically to improve the fit to observed flows.

Reservoir Evaluation System

(water resource systems 4th/00 W00-056)

The purpose of this work is to incorporate a family of reservoir tools, the HEC Reservoir Evaluation System (HEC-Res) into the Corps Water Management System (CWMS). The primary tool for CWMS is the system simulation program HEC-ResSim. Its capability is intended to meet the needs of water managers to make reservoir release decisions for complex systems of multi-purpose reservoirs. The reservoir analysis tools for flood and complex low-flow conditions are to be developed under the Hydrologic Engineering R&D program, Reservoir Analysis System Work Unit.

The HEC-Res Test Version 1 was completed and operational at the CWMS test sites during FY 1999. The program design for remaining Res functions was completed early in the second quarter of FY 2000. Program development for Test Version 2 was completed in the third quarter and was the emphasis of the HEC PROSPECT Reservoir Analysis course taught in June. Testing and program documentation continued during the fourth quarter.

River Hydraulics and Stage Forecasting

(hydrology & hydraulics technology 4th/00 W00-57)

During the fourth quarter of FY 2000, the unsteady flow routing previously incorporated into the CWMS system was tested. Additionally, graphical output for computed stage and flow hydrographs as well as water surface profiles, were implemented.

System Integration, Implementation, and Management

(water management systems 4th/00 W00-059)

Administrative activities included the updating of quarterly progress charts, and their integration with the required LCMIS quarterly report format. Weekly developer status meetings are held to coordinate the critical items being developed for Field Test Version 3.0.

As a result of the study and test of the CWMS client-server architecture when used in a wide area network (WAN) performed in the first and second quarters, several improvements were made to the CWMS software. These improvements include the local client caching of background maps and other information. This information is rarely changed, and should not need to be sent to the client each time the program is run. The first time a CWMS client accesses a specific watershed region from a server, the background maps are sent from the server to the client then stored on the local client machine. In subsequent accesses to the same watershed, the software checks to see if maps have been changed. If not, the maps are loaded from the local disk, otherwise they are re-sent. The user does not need to take any action for this caching to occur, although they may disable it through an 'options' menu.

Additional JPython scripting language capabilities were added. The initial implementation just controlled plotting capabilities. In this quarter, scripting capability was added to control the execution of the modeling programs, and changing parameters in the models prior to their runs. This is needed to be able to schedule model runs at specific times, without user intervention. It is anticipated that some offices will want to have initial model runs made in the early morning so that the results could be available to be reviewed when the staff arrives in the morning.

Application of GIS and Image Technology

(water management systems 4th/00 W00-060)

A study of network traffic generated by CWMS software identified ArcView (incorporated in CWMS through CorpsView) as placing high demands on the network. In response, the CorpsView developers at CRREL have begun re-evaluating the possibility of running ArcView locally on client machines, rather than over the network. Ongoing development of a Windows NT version of CorpsView will help facilitate this change if it is necessary.

Control and Visualization Interface

(water management systems 4th/00 W00-061)

The capability of executing 'supplemental programs' was added to the CAVI. This allows programs, other than the CWMS modeling programs, to be executed in a modeling run. An office may have a specialized program, such as a water quality program or estuary modeling program, that needs to run along with the CWMS models, and the supplemental programs feature of the CAVI provides that capability. Information about the run, such as the time window, alternative, etc., is passed to the supplemental programs.

Screens were developed to schedule modeling runs, using the JPython scripting language. Scheduled runs allow a user to select which models they would like to execute, and what parameter values to use, and schedule that run to occur at a given future time, up to seven days in the future. It is anticipated that some offices will want use this functionality to have initial model runs made in the early morning so that the results could be available to be reviewed when the staff arrives in the morning.

The time series and paired data plotting capability was enhanced. Users can specify a multitude of appearance factors, such as line thickness, color, shading, grids, fonts, labels, etc., through a screen accessed from a menu item on the plot. These factors can be applied to the current plot, or saved in a 'template file' for use in other plots.

Work continued on the design of the model interface module. Feedback from testers on the model interface module from Version 1 indicate that improvement was needed on the selection of models to run, and the presentation and comparison of results from those models.

Numerical Model Maintenance and Support

| Numerical Model Area | Primary Software | Calls for Assistance Last Four Quarters | | | | |
|--------------------------------|---|---|-------------------------------------|-------------------------------------|--|--------|
| | | 4 th Quarter FY 99 | 1 st Quarter FY 00 | 2 nd Quarter FY 00 | 3 rd Quarter FY 00 ² | Totals |
| Surface Water Hydrology | HEC-1, HMR52, HEC-HMS, HEC-IFH | 92 | 78 | 63 | 85 | 318 |
| River Hydraulics | HEC-RAS, HEC-2, UNET, HEC-6, HEC-GeoRAS | 69 | 35 | 40 | 84 | 228 |
| Flood Damage & Impact Analysis | HEC-FDA, HEC-FIA, HEC-SIA | 31 | 19 | 12 | 20 | 82 |
| Risk and Statistical Methods | HEC-FFA, STATS | 7 | 6 | 16 | 8 | 37 |
| Reservoir/Optimization Systems | HEC-5, HEC-5Q, HEC-PRM, HEC-RSS | 4 | 5 | 11 | 3 | 23 |
| Data Management Systems | HEC-DSS/DSPLAY | 24 | 3 | 15 | 2 | 44 |
| TOTALS | | 227 | 146 | 157 | 202 | 732 |

Surface Water Hydrology

(hydrology & hydraulics technology 4th/00 M00-001)

Maintenance this quarter concentrated on user support for HEC-HMS Version 2.0 both in application assistance and bug correction. Version 2.0.3 was released which corrected several significant errors in Version 2.0. Other support was provided for HEC-1, HMR52, urban H&H models; and the groundwater model MODFLOW.

River Hydraulics

(hydrology & hydraulics technology 4th/00 M00-002)

Application assistance and one-stop phone assistance continues at a high rate for HEC-RAS and UNET, while being moderate for HEC-6 and HEC-2. A final draft of the UNET 4.0 manual was completed. This manual is currently being reviewed for publication. Additionally, UNET Version 4.0 computer code was further tested before its release, which is expected early next FY.

Flood Damage and Impact Analysis

(water resource systems 4th/00 M00-003)

Consultations with Corps offices using risk-based analysis methods continued at a moderate to high rate during the fourth quarter. Minor corrections and updates to the HEC-FDA program and its database processing procedures were made. Research emphasis is presently on the design, coding, and user documentation of the new FDA Version 2.0 program scheduled for release near the end of FY 2001. It will include significant advances over the present version 1.2 of HEC-FDA.

Risk and Statistical Methods

(hydrology & hydraulics technology 4th/00 M00-004)

Support was provided for the HEC-FFA, Flood Frequency Analysis, and HEC-STATS, Statistical Analysis of Time-Series Data, software packages. Also, many general inquiries about flood frequency analysis were answered.

Reservoir Systems

(water resource systems 4th/00 M00-005)

General maintenance and field support activities for the HEC family of reservoir programs continued during the fourth quarter. Program updates and modifications for complex system operation goals continued. Program assistance was conducted on a request basis. An HEC-5 Version 8.1 is being prepared for release in FY 2001. The initial versions of the new HEC Reservoir Evaluation System (HEC-Res) set of programs for simulation (HEC-ResSim, low-flow water allocation using optimization methods (HEC-ResPrm), and flood control system optimization (HEC-ResFloodOpt) are all scheduled for release near the end of FY 2001.

Data Management Systems

(water management systems 4th/00 M00-006)

General support to the field in the area of data management (HEC-DSS) continued through this quarter. Work continued on the New GUI based product HEC-DSS VUE. This product is being developed in connection with the CWMS software (which takes priority in development). This quarter the tabulation capabilities were enhanced to provide for data editing, cut/copy/paste functions, and manual time series and paired data entry.

HEC-DSS and other HEC Programs may be downloaded from the HEC Web site (www.hec.usace.army.mil).

Technical Assistance and Special Projects

International Joint Commission

Red River Hydraulics Review

(hydrology & hydraulics technology 4th/00 P00-026)

The U.S. Section of the International Joint Commission, IJC, requested that HEC review an unsteady flow model of the Red River that flows north along the Minnesota-North Dakota border into Canada. HEC reviewed the UNET model formulation and geometric and hydraulic characteristics data and found the model to be sound. The model was obtained from the St. Paul District and several sensitivity analyses performed in this evaluation.

HQUSACE

CECW

FPMS Support

(water resource systems 4th/00 P00-011)

Headquarters Floodplain Management provided funds for HEC program support. A portion of the funds was used to enhance the HEC-GeoRAS analysis and spatial display capabilities. Also, coordination and technical assistance was provided to several FPMS offices during the fourth quarter.

Hydrology Committee

(hydrology & hydraulics technology 4th/00 P00-026)

Several telephone conferences of the Interagency Hydrologic Modeling Workgroup were held in preparation for the national workshop in November. HEC had a leading role in planning the workshop and inviting leading national hydrologic modelers to participate. The workshop will focus on software development philosophy and environment, roles of state/Federal/University/Private organizations, appropriate use and guidance for use of models, and measures of models performance.

Guidance Update

(water resource systems 4th/00P00-012)

This guidance effort was initiated during the second quarter and continued during the third quarter. It will produce a draft application guide to illustrate the hydrologic engineering analysis requirements for ecosystem/wetlands restoration and construction. It will be an appendix to EM 1110-2-1417, *Flood-Runoff Analysis*, and designed to assist Corps district staffs in the conduct of these studies by defining information, analysis considerations, and procedures required for hydrologic engineering analyses associated with various hydrologic regimes and environmental conditions. The guide will include numerous illustrations and examples with special topic exhibits as needed to define specific conditions and analysis examples. The key area addressed will be water balance analysis for low-flow base and alternative conditions. Information such as: flow and stage, velocities, durations, evaporation/transpiration, water supplies and demands, groundwater-surface water interaction, and water quality factors will be described. Hydrologic analysis requirements for flood analyses to evaluate any periodic maintenance needs and induced flooding effects will also be included in the document.

GREAT LAKES REGIONAL HQ

Detroit

Support for Plan 77A

(water management systems 4th/00 P00-005)

HEC provided support and continued development regarding the Coordinated Great Lakes Regulation and Routing Model for Detroit District. The model unifies and enhances several piecemeal programs employed by the Corps, Environment Canada, and NOAA's Great Lakes Environmental Research Lab. The work focused on testing the implementations of the Lake Superior regulation and routing through Lakes Michigan, Huron, St. Clair, and Erie; evaluating proposed changes to their methodology; documentation; and initiating development of the Lake Ontario/St. Lawrence River module. A training workshop was held 25-26 July 2000 in Detroit, MI.

Nashville

HEC-HMS on the Cumberland River

(hydrology & hydraulics technology 4th/00 P99-035)

A contract was let with Tennessee Tech University to assist HEC and the District in performing HEC-GeoHMS and HMS model development for the basin. The latest GeoHMS software was provided to the University along with assistance in its application. Some improvements to GeoHMS were made as a result of this new application. HEC's effort to apply the HMS continuous soil moisture accounting method to typical gaged basins in an effort to assess its use as compared the district's API method for HEC-1 will be postponed until next FY.

MISSISSIPPI VALLEY DIVISION

Rock Island

Regulated Flow Frequency Assistance

(hydrology & hydraulics technology 4th/00 P99-026)

This project was completed in the second quarter of 2000. Updated estimates of regulated flow for Saylerville and Red Rock Dunes on the Des Moines River, Iowa, were provided.

Upper Mississippi River Flood Profile Study

(hydrology & hydraulics technology 4th/00 P00-022)

This is an on-going project that is targeted for completion in FY 2002. Work this past quarter was focused on preparing for an upcoming stakeholder meeting, and adjusting work plans and schedules to reflect the tardy delivery of mapping products from the contractor.

NORTH ATLANTIC DIVISION

Baltimore

Anacostia River Watershed Feasibility Study

(water resource systems 4th/00 P99-023)

HEC is assisting the Baltimore District on its Anacostia River flood damage reduction feasibility study. The study is investigating the feasibility of levee raising and constructing wetlands between the levees. During FY 2000, and particularly during the 4th quarter, HEC has primarily worked with the district to develop an HEC-HMS model of the watersheds to assist in determining the best estimate of the discharge-frequency functions at two key gage locations. The final exceedance probability functions are particularly sensitive in that the present preliminary analyses show the District and Prince George's County with significant differences in the estimates. The final results affect levee sizing evaluations, FEMA levee certification, and existing county regulatory policies. During FY 1999, HEC assisted the district in defining the initial structural inventory and developed a preliminary HEC-FDA model for analyses.

Philadelphia

Susquehanna River

(hydrology & hydraulics technology 4th/00 P00-024)

HEC is working under contract for the Philadelphia District in the development of a flood warning and response system. This system requires the development of a detailed Hydraulic model, HEC-RAS, as well as the development of a flood damage model, FDA. The results from these two modeling efforts will be made available as part of an ArcView GIS system. Users will be able to enter the National Weather Service Susquehanna River stage forecasts for gage locations, and then plots of the inundated area will come up in ArcView. Additionally, tables will show information on potential damages and population at risk. Data collection by the District is taking longer than expected so the main HEC analysis will take place next year.

NORTHWESTERN DIVISION

Omaha

Fort Carson, CO Floodplain Determination

(hydrology & hydraulics technology 4th/00 P00-027)

The floodplain determination study for the Fort Carson Army base at Colorado Springs, Colorado, was completed for the District. The study determined the extent of flooding on the base for various flood frequencies and for existing and future development scenarios. HEC modeled the watershed using the Geospatial Hydrologic Modeling Extension, HEC-GeoHMS and the Hydrologic Modeling System, HEC-HMS. GeoHMS was used to delineate subbasins, determine their physical characteristics, and create grid-cell runoff parameters using digital elevation models and other GIS data. The HMS model used the Kinematic Wave land surface runoff transform and Muskingum-Cunge channel routing in the developed areas and Snyder's unit hydrograph method and Muskingum routing for the undeveloped areas. Incremental local flow from the HMS model was provided to the Omaha District for unsteady flow routing in the drainage channels.

SOUTH PACIFIC DIVISION

Lower Las Vegas Wash Habitat Restoration

(hydrology & hydraulics technology 4th/00 P00-029)

HEC contributed to a Corps workshop on riverine habitat restoration that was held in Las Vegas in conjunction with this project. Work continued on the hydraulic analysis for environmental restoration of Las Vegas Wash, Nevada. River geometry is being collected from Las Vegas to Lake Mead. The environmental restoration study will use spatially referenced data, analysis approaches, and displays. In particular, HEC-GeoRAS will identify flow velocities, depths, and inundated areas in the channel and floodplain. During a field trip at the workshop, it was decided to concentrate on two of the ongoing river control works under planning and construction. HEC developed GeoRAS and RAS models for those portions of the Wash. A draft report and guidance for such analyses were provided to the District.

Sacramento

Phase II Sacramento and San Joaquin River Basins Comprehensive Study

(water resource systems 4th/00 P00-001&002)

HEC continues to assist the Sacramento District with its Sacramento and San Joaquin River Basins Phase II Comprehensive Study. HEC's Phase I effort was completed in FY 1999. It developed basic level flood damage and reservoir system models for the Sacramento and San Joaquin watersheds. In Phase II, we completed the development of the comprehensive Hydrologic System (HEC-HMS) models for the two major watersheds and to continue to further refine the Phase I reservoir and flood damage models. Present efforts are ongoing to document the completed studies with a series of reports.

Motorola Superfund Project

(hydrology & hydraulics technology 4th/00 P00-023)

Assistance was provided in reviewing groundwater-modeling studies performed by contractors to the district. HEC's portion of the project was completed.

Tooele Groundwater

(hydrology & hydraulics technology 4th/00 P00-009)

The MODFLOW groundwater model of the Tooele Army Depot was updated for new well-flow measurements. This required an extensive recalibration effort and coordination with other Tooele studies being conducted at the District. Documentation of the model and new results will take place next FY.

SOUTHWESTERN DIVISION

Galveston

Lower Rio Grande Hydraulics Review

((hydrology & hydraulics technology 4th/00 P00-033)

HEC teamed with the Corps Coastal and Hydraulics Lab, CHL, to review a previous water surface profile study of the Lower Rio Grande near Brownsville. The International Boundary and Water Commission had questions about the previous Corps study. HEC, CHL, and District

engineers reviewed the river geometry and hydraulic characteristic data both from the report and in the field. Additional simulations were made which verified that the past analysis was correct. A joint report on the findings was produced.

OTHER

National Institute of Building Sciences

HAZUS

(executive 4th/00 P00-016)

The HEC Director serves on a panel that is providing oversight for the development of a FEMA sponsored hazards software package (HAZUS). The panel is addressing flood losses. Several product reviews and conference calls took place throughout this year. A meet of the full committee is planned for early next calendar year to assess progress on flood model development by the contractor.

TECHNOLOGY TRANSFER

There were two PROSPECT courses during the third quarter, as shown in the FY 2000 schedule in Table 1. The first, Flood Hydrology with HEC-HMS course provided participants with the knowledge to effectively utilize the HEC-HMS software to perform hydrologic analyses. The use of the new GeoHMS software to assist with the HMS model construct was an important part of the course.

The second course, Reservoir System Analysis, featured the new HEC Reservoir Evaluation System program HEC-ResSim that continues under development. The course also featured the emerging flood control optimization and prescriptive reservoir analyses programs, ResFloodOpt and ResPrm, respectively.

Other Training Activities

HEC held a Hydrologic Engineering Planners workshop in April for the Los Angeles District, as shown in Table 2

| Course Title | Date | Length (weeks) | No. of Students |
|---|----------------|----------------|-----------------|
| Advanced HEC-RAS | 24-28 Jan 2000 | 1 | 27 |
| H&H Applications for GIS | 13-17 Mar 2000 | 1 | 30 |
| Flood Hydrology with HEC-HMS | 08-12 May 2000 | 1 | 31 |
| Reservoir System Analysis | 19-23 Jun 2000 | 1 | 19 |
| Water and the Watershed | 17-21 Jul 2000 | 1 | 28 |
| Hydrologic Analysis of Wetlands/Restoration | 11-15 Sep 2000 | 1 | 27 |
| TOTALS: | | 6 | 162 |

Table 2. HEC FY 2000 WORKSHOPS

| Title | Sponsor | Date | Length (days) | No. of Students |
|--|--------------|-----------------------|---------------|-----------------|
| HEC-RAS (Bismarck, ND) | CEMVP | 4 - 7 Jan 2000 | 3.5 | 30 |
| Hydrologic Engineering for Planners | CESPL | 11-13 Apr 2000 | 3.0 | 36 |
| | | | | |
| | | | | |
| | | | | |
| TOTALS: | | | 6.5 | 66 |